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Currency Crises and Monetary Policy in Economies with Partial Dollarization of Liabilities

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Abstract

The right response to a speculative attack on the domestic currency by the monetary authorities in a country with dollarized liabilities has been a matter of hot debate among academics and policy makers especially after the East Asian Crisis. Using a modified version of the currency crisis model discussed in Proaño, Flaschel and Semmler (2005) we show that an increase of the domestic interest rate by the central bank as a response to the speculative attack can have serious negative effects on aggregate demand by depressing the investment of the subsector of domestic firms which are not indebted in foreign currency. We demonstrate that in specific situations the standard (IMF supported) increase of the domestic interest rate might not be the best response to a speculative attack on the domestic currency from the medium term point of view.

Keywords: Mundell-Fleming-Tobin model, liability dollarization, debt-financed investment, financial crisis, currency crisis, deflation.
JEL classifications: E31, E32, E37, E52.

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1 Introduction

The right response by the monetary authorities to a speculative attack on the domestic currency in a country with a significant fraction of foreign currency liabilities has been a matter of hot debate among academics and policy-makers in the years after the East Asian Crisis. Indeed, since a devaluation of the domestic currency can deteriorate dramatically the balance sheets of the domestic financial and entrepreneurial sectors by means of a currency mismatch between the value of assets and liabilities,[1] the majority of policy makers show a certain degree of "fear of floating"[2] and see in the defense of the prevailing exchange rate level the best response to a speculative attack, given the potential fragility of the domestic financial systems. Additionally, since only a limited amount of foreign reserves[3] is available to the central banks in the short run, and since the borrowing of foreign funds becomes more difficult during episodes of financial turmoil, an increase in the domestic interest rate (in order to make domestic bonds more attractive and hence reduce the pressure in the foreign exchange market) is considered by the majority of economists as the most appropriate, practicable and sustainable way to defend the prevailing exchange rate. Nevertheless, Radelet and Sachs (1998) and Furman and Stiglitz (1998), among others, have expressed serious concerns about the effectiveness and the adequacy of such a measure due to its potential negative effects on the aggregate investment and demand of the economy.

During the East Asian Crisis, the IMF officials chose the first point of view and advised the respective economies to increase domestic interest rates in order to prevent currency mismatches and the activation of credit constraints by financial sector. IMF Deputy Managing Director Shigemitsu Sigusaki for example stated: "We know that higher interest rate are likely to hurt the corporate sector, but an appreciation of the currency that follows a tightening of monetary conditions would greatly benefit those corporations indebted in foreign currency. There is no alternative in the short term. A relaxation of the monetary policy would only lead to further depreciations of the currencies".[4] Due to the fact that in the East Asian crisis nearly all exchange rate regimes collapsed due to the foreign exchange market pressures despite domestic nominal interest rate increases, the advice of the IMF

[1]See e.g. Eichengreen and Hausmann (1999), Mishkin (1996), Krugman (2000) and Kaminsky and Reinhart (2001). The theoretic models discussed in Aghion, Bacchetta and Banerjee (2001) and Flaschel and Semmler (2003) show how a currency crisis can lead to a widespread financial crisis and therefore to a significant economic slowdown due to the activation of credit constraints and the subsequent decrease in the aggregate investment.

[2]See Calvo and Reinhart (2002).

[3]Recent research has focused on the role of the international reserves of the central bank in the design of optimal monetary policy rules for small open economies, see Kato and Semmler (2005).

[4]See Radelet and Sachs (1998, p.49).

was sharply criticized in the years after, pushing forward even more the academic debate.[5]

The purpose of this paper is to explicitly model in a theoretical framework the exchange rate policy dilemma which the monetary authorities in emerging market economies are facing and to explore to what extent the orthodox monetary policy recommendation of an increase in the domestic interest rate is the right measure to follow during a speculative attack, in an economy with a fraction of liabilities denominated in foreign currency. A similar line of research has been recently pursued also by Christiano, Gust and Roldos (2004) and Braggion, Christiano and Roldos (2005) within a general equilibrium framework. Their work however does not take into account country specific characteristics, as e.g. different interest rate elasticities of aggregate money demand, for the monetary policy reaction to financial crises, as our model does.[6]

In our framework the optimal response by the monetary authorities to a speculative attack on the domestic currency depends on the degree of foreign currency indebtedness in the economy (and therefore on the potential impact of a currency mismatch) and on the elasticity of aggregate investment demand with respect to domestic interest rate changes. We attempt to highlight the pitfalls of *one-size-fits-all* receipts for the conduct of monetary policy in emerging market economies.

The remainder of the paper is structured as follows. In section 2 we present some empirical facts concerning the impact of nominal exchange and interest rates on aggregate investment in selected East Asian countries by means of a VARX analysis. In section 3, the model developed in Proaño et al. (2005) is modified to capture in particular the negative influence of an increase in the domestic interest rate on aggregate demand, i.e., we explicitly model the dilemma exchange rate policy is facing in emerging market economies. We discuss the role of the international reserves on the onset of a currency crisis and explore the local stability properties of the modified model also in section 3. Section 4 analyzes on this basis different policy scenarios that are conceivable in the modified model when the exchange rate policy dilemma is taken into account. Empirical evidence which supports the results of

[5]See Corsetti, Pesenti and Roubini (1999) and Radelet and Sachs (1998).

[6]Furthermore, the authors do not explicitly focus on the currency mismatch problem and their model does not possess multiple equilibria as our theoretic framework does. The authors summarize the somewhat puzzling results of their model in the following way: "the optimal response to a financial crisis is an initial sharp rise in the interest rate, followed by a fall to below pre-crisis levels."Braggion et al. (2005, p.1). This conclusion, nevertheless, is erroneous because the initial rise in the interest rates is not a consequence of monetary policy actions but the outcome of the activation of the credit constraints and therefore the increase in the value (in units of the traded good) of the capital stock in the traded and non-traded sector, see also Braggion et al. (2005, p.16). Only the subsequent fall in the interest rates can be seen as the result of policy actions since it comes from the injection of liquidity by the monetary authorities.

the theoretical model developed in the section 4 is also presented there. Section 5 concludes.

2 VARX Analysis

The East Asian, as well as the Mexican (1994-95) crisis, is a quite particular episode in recent history due to the abruptness and extent to which the real side of the economy was affected by the sharp devaluations of the domestic currency. As previously discussed, the fact that in the majority of cases the domestic monetary authorities tried, unsuccessfully, to defend the prevailing nominal exchange rate by raising the domestic short term interest rates (a measure which was recommended by the IMF) raises the question whether that strategy was not in part responsible for the subsequent sharp decline in the aggregate demand, and especially in the aggregate investment, as it will be discussed below in the model scenario sketched in figure 7.

In figure 1 we show time series data of Mexico and selected East Asian countries for the 1990s, the decade when currency and financial crises took place in those countries. In all cases a sharp nominal exchange rate depreciation, caused by a successful speculative attack, as well as a rise in the domestic interest rates (due to the intervention of the domestic monetary authorities) preceded an abrupt and severe decline in the aggregate investment activity in the following quarters.

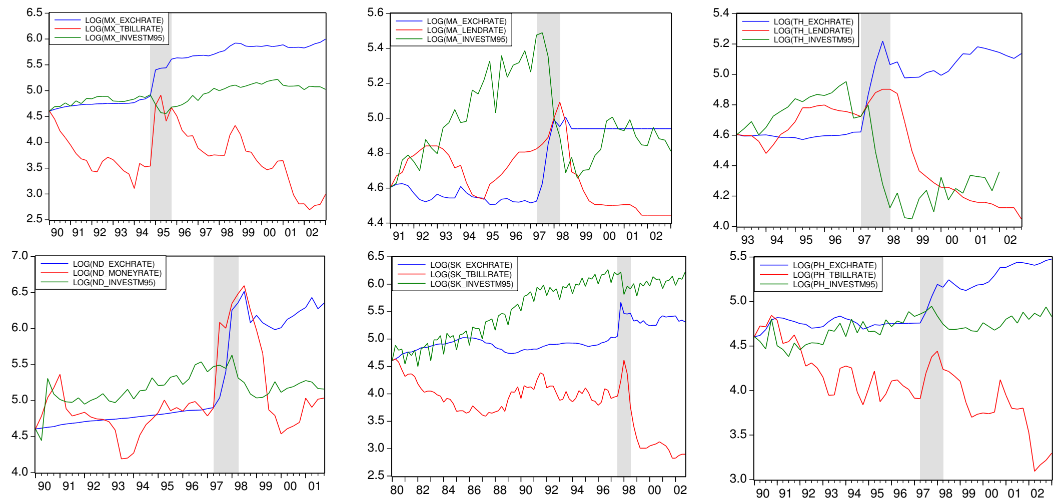


Figure 1: Real Aggregate Investment, Exchange and Interest Rates
(First Quarter = 100, in logs)

This collapse of the aggregate investment in nearly all attacked East Asian countries has been explained by the majority of researchers by means of an open-economy version of the financial accelerator concept introduced by Bernanke, Gertler and Gilchrist (1994), which explains the credit awarding by the financial intermediaries as being dependent on the net worth of the entrepreneurial sector. Now, since in the 1990s the domestic firms in many emerging market economies obtained new access to international credit (normally in foreign currency) due to financial markets liberalization during that decade, their state of their balance sheets became also dependent on the nominal exchange rate. In the next section we investigate, in a very simple manner, the dynamic interaction of the nominal exchange rate, the domestic nominal interest rate and the aggregate investment in a sample of East Asian countries by means of an unrestricted VARX (vector autoregressive model with exogenous terms) estimation.[7]

For our analysis we use time series data of aggregate investment (in constant 1995 prices, seasonally adjusted), the respective nominal bilateral US-Dollar exchange and domestic interest rates of Mexico (MX), Malaysia (MA), Thailand (TH), Indonesia (ND), South Korea (SK) and the Philippines (PH) stemming from the International Statistical Yearbook 2003. As endogenous variables in the VARX model we use the logs of these variables. The exogenous variables in the model are impulse dummies which capture the nonlinear sharp nominal depreciations resulting from the speculative attacks on the respective currencies. The lag order of the VARX models was chosen according to the Schwarz information criterion. We report these statistics, the VARX estimation results (obtained by Generalized Least Squares) as well as the corresponding residual serial correlation LM tests for all estimated countries in the appendix.

For the impulse response analysis of the estimated VARX models we use generalized one standard deviation innovations as proposed by Pesaran and Shin (1998). The principal advantage of this type of impulse response analysis is that the resulting impulse response functions (generated by an orthogonal set of innovations) are independent of the ordering of the endogenous variables in the VARX model, in contrast to the standard Cholesky orthogonalization procedure. We show the estimated dynamic responses of the real aggregate investment to a generalized one standard deviation shock in the nominal exchange and interest rate below.

As can be observed in figure 2, the reaction of aggregate investment to a shock in the nominal exchange rate and interest rate varies significantly across countries. While in Mexico the extent and duration of both responses was relatively low (what would explain the fast recovery of the Mexican economy after the 1994-1995 Tequila crisis), in the other countries the recovery of aggregate investment has a much longer duration. An additional and probably more interesting finding is the heterogeneous relative strength of the nominal exchange and interest rates across countries. While

[7]See Lütkepohl (1993).

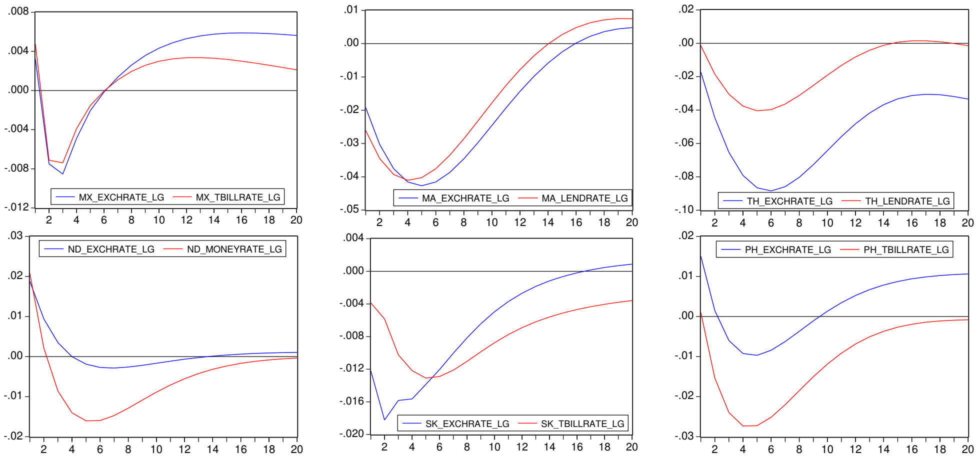


Figure 2: Response of the Log of Aggregate Investment to a Generalized One Std. Dev. Innovation in the Logs of the Nominal Exchange and Interest Rates

in Mexico, Malaysia, Thailand and South Korea the exchange rate shock affects in a more significant manner the respective aggregate investment levels, in Indonesia and the Philippines the interest rate effect seems to have predominated during the estimation period. Now, even if these empirical findings are not definitive in their implications with respect to the main determinant (if there was only one) of the investment decline in the East Asian countries, they nevertheless open up the question whether, at least in some countries, the defense of the currency pegs through interest rate increases might perhaps not have been the most adequate response to the speculative attacks on the domestic currencies. In the next section we develop a theoretical model which might shed some light on this discussion.

3 The Model

We analyse a small open economy of Mundell-Fleming-Tobin type as basically discussed in Rødseth (2000). The analyzed time span is assumed to be short enough to allow for the assumption of a basically unchanging capital stock K as well as private financial wealth W_p, the firms' foreign currency and domestic currency debt F_f and B_f, respectively, despite the presence of positive or negative net investment and households' savings. Since foreign prices are assumed to be constant and are normalised to one ($p^* = 1$), the real exchange rate can be defined as $\eta = e/p$. In contrast to Flaschel and Semmler (2003) and Proaño et al. (2005), where the totality of the domestic firms financed its investment projects through foreign currency denominated credit (which implied that the domestic interest rate did not affect the aggregate demand directly), we assume here that there are two different groups of firms in the economy which desire to undertake investment projects. While a fraction of the domestic firms υ finances its investment projects through foreign currency denominated credits, the other fraction $(1-\upsilon)$ borrows domestic currency.[8] The balance sheet of the two fractions of domestic firms is represented in table 1 as following: The net worth of a firm is defined as the difference between its assets

Table 1: Business Sector's Balance Sheets

	Business Sector's Balance Sheets	
Firms' Fraction	**Assets**	**Liabilities**
υ	υpK	eF_f
$1-\upsilon$	$(1-\upsilon)pK$	B_f

and its liabilities (both expressed here in domestic currency). Note that while the exchange rate influences the net worth of the firms with foreign currency liabilities, the net worth of the other fraction of firms $(1-\upsilon)$ remains unaffected by changes in the exchange rate.

Based on the financial accelerator concept introduced by Bernanke et al. (1994), we assume that banks (domestic and foreign) evaluate the creditworthiness of the domestic firms based on their actual net worth, or more precisely on their debt-to-capital ratio $\tilde{q}^{\upsilon} = eF_f/\upsilon p\bar{K} = \tilde{q}^{\upsilon}(\eta)$ and $\tilde{q}^{1-\upsilon} = B_f/(1-\upsilon)pK$ (we assume here $F_f < 0$ and $B_f < 0$, indicating a negative foreign and domestic currency bond stock held by domestic firms, or in other words, that firms are indebted). Despite the fact that both groups might be subject to the imposition of credit constraints by the financial sector, their net worth is composed in a different way.

A glance at the balance sheet of the fraction of domestic firms υ can clarify why a devaluation of the real exchange rate has a negative effect on credit awarded by banks to the group of firms with foreign currency liabilities υ: a rise of the nominal exchange rate (or an decrease of the domestic price level) leads to an increase in the nominal (and here also real) value of the liabilities of this group and therefore to a decrease in its net worth. The other share of domestic firms $(1-\upsilon)$, which is not indebted in foreign currency, is not affected by a devaluation of the domestic currency. We assume that the totality of the foreign currency debt is unhedged. As discussed e.g. in Röthig, Flaschel and Semmler (2005), with increasing currency hedging by the domestic firms, the fragility of the real side of the economy to unexpected exchange rate depreciation decreases.

[8]For simplicity we assume that each firm possesses the same amount of capital so that the distribution of the aggregate capital stock between these two groups is represented also by υ.

The aggregate investment function, consistent with the aggregate investment by the two groups, can be thus expressed as

$$I = \upsilon I\left(\bar{i}^{*}, \tilde{q}^{\upsilon}(\eta)\right) + (1-\upsilon) I\left(r, \tilde{q}^{1-\upsilon}\right). \tag{1}$$

with $\bar{r}^{*} = i^{*} - \hat{p}^{*} = r^{*}$ and $r = i - \hat{p}$. Despite the fact that the share of domestic firms borrowing in υ is kept constant here, one could think of it as being a function of the risk premium ξ. For now we will just assume that due to financial technology differences or firm size factors not the totality but only a constant fraction of the domestic entrepreneurial sector can actually obtain credits denominated in foreign currency.

As in Krugman (2000), we assume that the elasticity of the investment function with respect to η is state-dependent, so that while for high and low values of η (of $\tilde{q}^{\upsilon}$) the investment reaction is assumed to be inelastic, for intermediate values of η (of $\tilde{q}^{\upsilon}$), by contrast, the elasticity of the gross investment function with respect to changes in the real exchange rate (in the debt-to-capital ratio) is high, reflecting the nonlinear activation of credit constraints by the financial sector. Such an aggregate investment function is shown in figure 1.

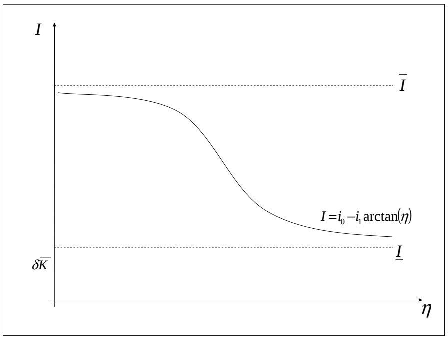


Figure 3: A Balance Sheet Dependent Investment Function

Even though the above gross investment function is of a very simple nature, it incorporates the financial accelerator concept and, more generally, the basic implications of the theory of imperfect capital markets, leading to the possibility of multiple equilibria and, therefore, to the existence of "normal" and "crisis" steady states respectively. Note nevertheless that the magnitude of the balance sheet effect depends in a great manner on υ, that is on the degree of liability dollarization of the economy. For $\upsilon = 1$, i.e. in the case of total liability dollarization (as in Flaschel and Semmler (2003)), the balance sheet effect alone (except changes in the foreign interest rate) determines the level of aggregate investment. For $\upsilon = 0$, on the contrary, changes in the real exchange rate do not directly affect the financial state of the domestic firms.

The goods market equilibrium can again be expressed as

$$Y = C_1(Y - \bar{T}) + I(\bar{i}^*, \tilde{q}^{\upsilon}(\eta), r, \tilde{q}^{1-\upsilon}) + \delta\bar{K} + \bar{G} + X(\bar{Y}^*, \eta). \tag{2}$$

with $Y - \bar{T}$ denoting the disposable income, $\bar{T}$ lump sum taxes, $\bar{G}$ the government consumption and $\delta\bar{K}$ the capital depreciation. Note that we have removed here from explicit consideration all imported consumption goods C_2 and thus have reduced the representation of aggregate demand to include only domestic consumption goods $C_1 = C - eC_2$. In view of this only exports X, which depend in a standard way positively on the foreign output level (assumed for simplicity to be at its natural level) and on the real exchange rate $\eta = e/p$ (the foreign goods price still set equal to one), have therefore to be considered from now on.

The dynamic multiplier is now based on the law of motion

$$\dot{Y} = \beta_y \left[C_1(Y - \bar{T}) + I(\bar{i}^*, \tilde{q}^{\upsilon}(\eta), r, \tilde{q}^{1-\upsilon}) + \delta\bar{K} + \bar{G} + X(\bar{Y}^*, \eta) - Y\right] \tag{3}$$

The slope of the $\dot{Y}=0-$isocline is described in the extended phase space (η, Y) by:

$$\left.\frac{\partial Y}{\partial \eta}\right|_{\dot{Y}=0} = -\frac{\upsilon I'(\eta) + X'(\eta)}{C_Y - 1}$$

It can easily be seen that the slope of the $\dot{Y}=0-$isocline depends on which of the two opposite effects dominates: the balance-sheet-effect $\upsilon I'(\eta) < 0$ or the competitiveness effect $X'(\eta) > 0$:

$$|\upsilon I'(\eta)| > X'(\eta) \Longrightarrow \left.\frac{\partial Y}{\partial \eta}\right|_{\dot{Y}=0} < 0$$

and

$$|\upsilon I'(\eta)| < X'(\eta) \Longrightarrow \left.\frac{\partial Y}{\partial \eta}\right|_{\dot{Y}=0} > 0.$$

From the shape of the assumed investment function we conclude (if its interior part is sufficiently steeper than its counterpart in the export function) that for intermediate values of η (of $\tilde{q}^{\upsilon}$) the creditworthiness (the balance-sheet) effect is stronger than the "normal" competitiveness effect, changing the slope of the $\dot{Y} = 0-$isocline and therefore opening up the possibility of multiple equilibria now in the (η, Y) phase space. Note that the strength of the balance-sheet effect on the aggregate demand depends on the degree of dollarization of liabilities in the economy υ: For $\upsilon = 1$, the balance-sheet effect operates with full strength, while for $0 < \upsilon < 1$ this effect operates only partially.

The domestic monetary authorities are assumed to determine the short-term nominal interest rate by the following Taylor rule

$$i_{tr} = (i_o - \bar{\pi}) + \hat{p} + \alpha_p(\hat{p} - \bar{\pi}) + \alpha_u(u - 1). \tag{4}$$

where $u = Y/\bar{Y}$ denotes the actual capacity utilization rate in the domestic economy, i_o the steady state nominal interest rate and $\bar{\pi}$ the inflation rate targeted by the domestic central bank. Concerning the remaining financial sector, we allow as in Rødseth (2000) the domestic and foreign currency denominated bonds to deliver different rates of return in the short run. The defining financial market equations are:

$$\begin{array}{rrl}
\text{Private Sector's Initial Wealth} & W_p = & \dfrac{B_{po} + eF_{po}}{p} \qquad (5) \\
\text{Risk Premium} & \xi = & i_{tr} - \bar{i}^* - \epsilon \qquad (6) \\
\text{Foreign Currency Bond Market} & \frac{eF_p}{p} = & f(\underset{-}{\xi}, \underset{+}{W_p}, \underset{+}{\kappa}), \qquad (7) \\
\text{Domestic Currency Bond Market} & \frac{B_p}{p} = & W_p - f\,(\xi, W_p, \kappa) \qquad (8)
\end{array}$$

$$\text{Equilibrium Condition} \qquad F_p + F_c + \bar{F}_* = 0 \qquad \text{or} \qquad F_p + F_c = -\bar{F}_*. \tag{9}$$

Eq.(5) describes the initial financial wealth of the private sector, consisting of bonds in domestic currency B_{po} and foreign currency denominated bonds F_{po}, all expressed in real domestic currency terms. Domestic and foreign currency denominated bonds are allowed to deliver different rates of return, meaning that the uncovered interest rate parity does not necessarily hold, at least in the short run. The resulting risk premium of holding domestic currency bonds, i.e. the expected rate of return differential between the two interest bearing financial assets, is represented by eq.(6). ϵ denotes the expected rate of currency depreciation, which we assume to be determined by

$$\epsilon = (e_o/e - 1).$$

For the steady state exchange rate e_o, $\epsilon(e_o) = 0$ obviously holds. This expectation formation mechanism can be considered as purely forward looking and in this respect asymptotically rational, since the economic agents, having perfect knowledge of the future steady state exchange rate e_0, expect the actual exchange rate to converge monotonically to it after each shock that affects the economy.

Eq.(7) represents the market equilibrium for foreign currency denominated bonds. Hereby the demand for these type of financial assets is assumed to depend negatively on the risk premium, positively on the private financial wealth and positively on the parameter κ, which acts as a catch-all variable of foreign market pressures like political instability or speculative herding behavior. Note that in contrast to Flaschel and Semmler (2003) here we do not explicitly model the domestic money market, which we substituted by the Taylor rule given by eq.(4) and which we assume now to be in equilibrium via Walras law of stocks.

The equilibrium condition for the foreign exchange market states that the aggregate demands of the three sectors – domestic private sector and monetary authority, and the foreign sector – always sum up to zero, see Rødseth (2000, p.18). If we assume that the supply of foreign-currency bonds available to the private sector (additionally to its own stocks) is solely controlled by the monetary authorities,[9] then the prevailing exchange rate depends on the disposition of the central bank to supply the private sector with foreign-currency bonds.

By inserting eq.(5) in eq.(7), we obtain a market-based adjustment mechanism for the nominal exchange rate (in the case of a flexible exchange rate regime) of the following form

$$\dot{e} = \beta_e \left[f\left(i_{tr} - \bar{i}^* - \beta_\varepsilon (e_o/e - 1), \frac{B_p + eF_p}{p}, \kappa \right) - \frac{eF_p}{p} \right]. \tag{10}$$

Partial derivation with respect to Y constraint to eq.(4), delivers

$$\frac{\partial \dot{e}}{\partial Y} = \beta_e f'(\xi) i'_{tr}(Y) < 0.$$

Concerning the domestic price dynamics, we use a simple expectations augmented, open-economy wage-price Phillips-curve (on the assumption of a constant productivity production function and mark-up pricing) which can be written as

$$\hat{p} = \beta_p (Y - \bar{Y}) + \hat{p}_c^e \text{ with } p_c = p^\theta (ep^*)^{1-\theta}, \ \theta \in (0,1). \tag{11}$$

We now use p_c for the consumer price level, based on a geometric mean of the domestic and the foreign price level, both expressed in the domestic currency. Superscript e denotes expectations, implying that marked up domestic wage inflation is explained in this Phillips Curve by the output gap and the expected consumer price inflation rate. In Proaño et al. (2005) this open economy Phillips Curve was reduced to

$$\hat{p} = \frac{\beta_p}{1-\theta}(Y - \bar{Y}) \quad \text{or} \quad \dot{p} = \tilde{\beta}_p (Y - \bar{Y}) p.$$

due to the assumption that the exchange rate as well as the foreign price level is kept fixed and that in addition that current domestic inflation is perfectly foreseen.

[9] This assumption can be justified by assuming as in Rødseth (2000) that domestic bonds cannot be traded internationally.

Now, if we drop the assumption of a constant nominal exchange rate and allow it to (eventually) fluctuate (and the agents to incorporate their expected exchange rate changes in their price setting behavior), the Phillips Curve turns to

$$\hat{p} = \tilde{\beta}_p(Y - \bar{Y}) + \beta_\epsilon(e_0/e - 1) \quad \text{or} \quad \dot{p} = \Big(\tilde{\beta}_p(Y - \bar{Y}) + \beta_\epsilon\,(e_o/e - 1)\Big)\,p. \tag{12}$$

We now turn our attention to the real exchange rate $\eta = e/p$, which time derivative $\dot{\eta}$ is given by

$$d\eta/dt = \frac{\dot{e}p - e\dot{p}}{p^2} = \frac{1}{p}\,(\dot{e} - e\hat{p})\,.$$

From this formulation follows that $\dot{\eta} = 0$ when $\hat{e} = \hat{p}$. This solution, nevertheless, is not stable from a dynamic point of view and it additionally lacks of economic foundations. The true solution for which the real exchange rate remains constant ($\dot{\eta} = 0$) is when simultaneously $\dot{e} = 0$ and $\dot{p} = 0$ hold. The first condition $\dot{e} = 0$, i.e. the equilibrium in the domestic financial (money, domestic and foreign currency) markets is fulfilled per definition in a pegged exchange rate regime at every period of time – eventually through central bank interventions in the foreign exchange market. In the medium run, additionally, the nominal exchange rate is at its steady state value, i.e. $e = e_0$, so that $\dot{\epsilon} = 0$. In the absence of expected nominal exchange rate depreciations in the medium run, $\dot{p} = 0$ holds only if $Y = \bar{Y}$. Since there is no restriction on the domestic price level in the medium run, follows that the $\dot{\eta} = 0$ isocline in the $(\eta, Y)-$space is a vertical line which cuts the $Y-$ axis at $Y = \bar{Y}$. Note that in contrast to the $\dot{p} = 0$ isocline described in Proaño et al. (2005), the $\dot{\eta} = 0-$isocline here does not only represent the Phillips Curve and therefore the medium run equilibrium in the labor markets, but it also represents the medium run equilibrium in the financial markets. Here thus, we have a clear theory of real exchange rate determination, which states that while the nominal exchange rate is determined in the financial markets, the domestic price level is set primarily in the goods and labor markets. Therefore we call the $\dot{\eta} = 0-$isocline the PCFM-curve.

3.1 The Role of the International Reserves

The level of the international reserves of a country is considered as one of the main determinants for the propensity and fragility of a country to a speculative attack on its domestic currency. Obviously, this depends on the exchange rate regime which the country possesses. While in a flexible exchange rate system the domestic central bank does not have to intervene in the foreign exchange market, in a pegged exchange rate system the domestic monetary authorities are compromised to serve any demand for foreign currency with their foreign exchange holdings. Since at the onset of a speculative attack a country might be cut off from foreign liquidity credit, the level of its international reserves determines its capability to defend the prevailing currency peg, and therefore also the credibility of the latter.

We can incorporate these considerations in our theoretical model in the following manner: While in a flexible exchange rate system the exchange rate dynamics are still given by eq.(10), in case of a currency peg the dynamics of the international reserves have to be considered. We assume thus that in this case the demand for foreign currency bonds by the private sector is augmented by an additional term, which incorporates in a quite simple manner the role of the international reserves discussed above:

$$\frac{eF_p^D}{p} = f\left(\underset{-}{\xi}, \underset{+}{W_p}, \underset{+}{\kappa}, \underset{+}{\left(F_c - F_c^{min}\right)^{-1}}\right) \quad \text{with} \quad F_c > F_c^{min}, \tag{13}$$

where F_c^{min} denotes the minimal, critical level of international reserves at which the domestic monetary authorities would give up the currency peg and let the exchange rate float. Obviously, for $F_c \rightarrow F_c^{min}$, $f'(F_c) \rightarrow +\infty$. The dynamics of the international reserves in our basic theoretical model in a pegged exchange rate system would then be determined by

$$\dot{F}_c = -\dot{F}_p = \frac{eF_p}{p} - f\left(\underset{-}{\xi}, \underset{+}{W_p}, \underset{+}{\kappa}, \underset{+}{\left(F_c - F_c^{min}\right)^{-1}},\right). \tag{14}$$

Eq.(14) highlights the destabilizing character of the international reserves: Since

$$\frac{\partial \dot{F}_c}{\partial F_c} > 0,$$

holds, a decrease in the international reserves leads to a higher foreign currency demand by the domestic private sector and therefore to an accelerated lowering of the international reserves, and viceversa. If the level of actual international reserves dangerously decreases near to the minimum level of international reserves owned by the domestic central bank F_c^{min} – from an objective point of view as the liquidity requirement to assure a frictionless international trade –, the domestic monetary authorities would not have in the short run any other alternative but to give up the prevailing peg and let the currency float. The dynamics of the floating exchange rate would then be determined by eq.(10).

3.2 Local Stability Analysis

The model consists, in the flexible exchange rate regime, of the following differential equations:

$$\begin{aligned}
\dot{Y} &= \beta_y \left[C_1(Y-\bar{T}) + I(\bar{i}^*, \tilde{q}^{\upsilon}(\eta), r, \tilde{q}^{1-\upsilon}) + \delta\bar{K} + \bar{G} + X(\bar{Y}^*, \eta) - Y\right] \\
\dot{\eta} &= \frac{\beta_e}{p}\left[f\left(i_o + (1+\alpha_p)(\beta_p(Y-\bar{Y}) + \beta_\epsilon(e_0/e-1) - \bar{\pi}) + \alpha_u(Y/\bar{Y}-1)\right.\right. \\
&\quad \left.\left. -\bar{i}^* - \beta_\varepsilon(e_o/e-1), W_p, \kappa\right) - \eta F_{po}\right] - \left(\tilde{\beta}_p(Y-\bar{Y}) + \beta_\epsilon(e_o/e-1)\right)\eta
\end{aligned}$$

The first differential equation is the standard goods markets adjustment mechanism. The second equation gathers eq.(10) and eq.(12) and represents the adjustment of the real exchange rate to changes in Y. As it can easily be seen, for $Y > \bar{Y}$ the real exchange rate appreciates, i.e. $\dot{\eta} < 0$. This development results from two effects: on the one hand, a rise in Y above $\bar{Y}$ leads to a nominal interest rate increase due to the Taylor rule and therefore to a nominal exchange rate appreciation , i.e. $\dot{e} < 0$. On the other hand, for $Y > \bar{Y}$ follows that $\dot{p} > 0$. The additional term of exchange rate expectations only strengthens this effect (but it is not its main determinant). For $Y < \bar{Y}$, the opposite holds.

The Jacobian of this system is

$$J = \begin{bmatrix} \beta_y\left[C'(Y)-1\right] & \beta_y\left[\upsilon I'(\eta) + X'(\eta)\right] \\ \frac{\beta_e}{p} f'(\xi)((1+\alpha_p)\beta_p + \alpha_u) - \beta_p\eta & \frac{\beta_e}{p}(f'(W_p)F_{po} - F_{po}) \end{bmatrix}.$$

Because of the nonlinearity of the $\dot{Y}$=0−isocline there exist in the considered situation three economically meaningful steady states, whose local stability properties can be easily calculated:

$$J_{E1} = \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E1}) < 0, \quad det(J_{E1}) > 0 \Longrightarrow \text{stable steady state}$$

$$J_{E2} = \begin{bmatrix} - & - \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E2}) < 0, \quad det(J_{E2}) < 0 \Longrightarrow \text{saddle point}$$

$$J_{E3} = \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E3}) < 0, \quad det(J_{E3}) > 0 \Longrightarrow \text{stable steady state.}$$

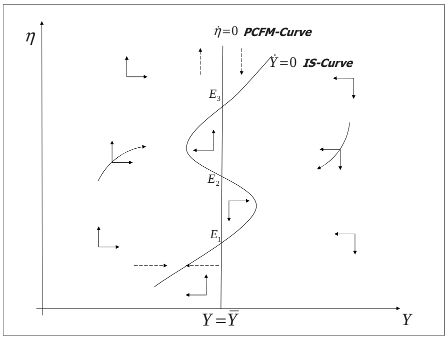


Figure 4: The IS-PCFM Model

The resulting phase diagram of this currency crisis model is sketched in figure 4.

Steady state $E1$ represents the "normal" steady state, where the economy's output is high as well as the domestic investment activity. In this steady state, the standard case $|I'(\eta)| < X'(\eta)$ holds. Steady State $E2$ represents the fragile case with $|I'(\eta)| > X'(\eta)$: Because a slight deviation of the output level from this steady state level can lead the economy to a short-run investment boom or to a decline in the economic activity, this equilibrium point is unstable. Steady State $E3$ constitutes the "crisis equilibrium". At this equilibrium point the investment activity is highly depressed due to the high value of e. Nevertheless, the slope of the $\dot{Y} = 0-$isocline is again positive because of $|I'(\eta)| < X'(\eta)$ describing the dominance of exports over (the remaining) investment demand in the considered situation.

4 Twin Crises Scenarios and Medium Run Real Exchange Rate Adjustments

4.1 The Case of Total Liability Dollarization $\upsilon = 1$

In order to highlight the implications of the incorporation of the domestic interest rate in the aggregate investment function of our model, we discuss first the resulting dynamics for the complete liability dollarization case ($\upsilon = 1$), as it was the case in Flaschel and Semmler (2003) and Proaño et al. (2005). Assume the economy is initially situated at its NAIRU employment level in steady state $E1$. A speculative attack on the domestic currency can be represented in our model by an increase of the parameter α in the foreign currency bond demand. As long as the monetary authorities can defend the old currency peg, the flight into foreign currency does not have any effects besides the reduction of the foreign exchange reserves of the central bank according to eq.(14) (because a constant money supply is assumed, a full sterilization of monetary base changes by the central bank is also implicitly assumed). Now suppose that the central bank gives in to the foreign market pressure due to, say, a dangerous approaching of the international reserves to the critical level F_c^{min}. As a result of a speculative attack on the domestic currency, the nominal exchange rate devaluates sharply, triggering the activation of credit constraints by the financial sector and depressing so the level of aggregate investment and therefore of the entire economic activity. In the model discussed in Proaño et al. (2005), the new exchange rate level after the one-time devaluation was assumed for simplicity to be considered by the economic agents as "sustainable". Here, on the contrary, this must not be the case, as we will discuss below.

In the (η, Y) - space, the short run sharp nominal exchange rate devaluation is represented by a "jump" of the value of η along the $\dot{\eta} = 0-$ isocline up to point B.[10] Now, due to the dynamic adjustment mechanism in the goods markets, Y declines so that $Y < \bar{Y}$. This development has two effects, as already discussed in the previous section. On the one hand (assuming now a post-crisis flexible exchange rate regime), a decrease in Y leads to a fall in the domestic interest rates and to a higher demand for foreign bonds and, in a flexible exchange rate regime, to a further rise in e. On the other hand, the underemployment situation leads to a fall in the domestic price level, i.e. $\dot{p} < 0$. Both effects lead to a strong depreciation of real exchange rate, helping so the economy to return to its NAIRU employment level through the expansion of the domestic exports. Obviously, in a post-crisis fixed exchange rate regime, a much more severe deflationary process than in a flexible exchange rate regime is required for the domestic economy to return to its pre-crisis NAIRU level of employment, as discussed in Proaño et al. (2005). These dynamics are sketched in figure 5. Since now the nominal exchange rate is allowed to float after the occurrence of the currency crisis, there is no necessity for a severe deflationary process in order to reach the NAIRU consistent output again. Further nominal exchange rate adjustments (in this case depreciations) can also contribute for the real exchange rate to devalue.

As stated before, in the case of total liability dollarization, a defense of the prevailing exchange rate level by the domestic monetary authorities does not have a direct effect on the aggregate demand because the domestic firms finance their investment projects completely through foreign currency credit. Theoretically, the monetary authorities can thus indefinitely increase the domestic interest rates in order to reduce the pressure on the exchange rate without directly affecting the real sector of the economy. Such a measure can reduce the magnitude of an eventual nominal

[10] We assume that the nominal depreciation is of such magnitude that B lies above the unstable steady state $E2$. We will discuss the case where B lies below $E2$ below.

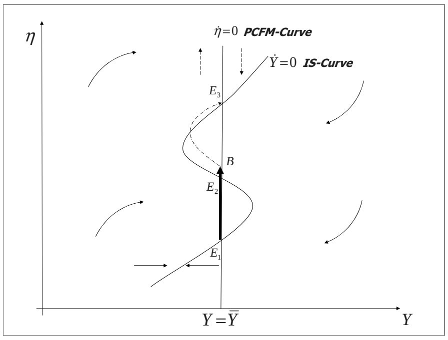


Figure 5: The Consequences of a Breakdown of the Currency Peg in the Case of Total Liability Dollarization

depreciation and might even generate a short run expansion due to the expansion of the net exports, if the real exchange rate jumps in the short run only to a point B' below the steady state $E2$.

Supplement: Dynamics with a "Kinked" Phillips Curve

As already Keynes (1936) noticed, an economy-wide wage and price deflation of great magnitude is unlikely to happen in modern economies. Indeed, numerous studies have shown that wages are downwardly rigid in the majority of countries. Taking this empirical fact into consideration the Phillips Curve can be modified in the following way:

$$\hat{p} = \max\left\{\tilde{\beta}_p(Y - \bar{Y}) + \beta_\epsilon \left(e_o/e - 1\right), 0\right\}. \quad (15)$$

This modified Phillips-Curve implies that in under-employment situations prices do not fall but instead remain constant. Price changes can only take place in over-employment situations, where the price level is assumed to rise as before.

The empirical observation of downwardly rigid wages had important consequences for the dynamics of the model described in Proaño et al. (2005). Because in that paper a post-crisis fixed exchange rate level was assumed, the price deflation was the only process which enabled the economy to return to the NAIRU-employment level. If prices are downwardly rigid, the economy loses that recovery mechanism and is "condemned" to remain at the "crisis equilibrium" as shown in Flaschel and Semmler (2003).

Here, in contrast, downward wage rigidity does not "condemn" the economy to remain in such under-employment equilibria due to the absence of a way to re-gain competitiveness and therefore to increase the level of exports again. In the presence of downward rigidity the nominal exchange rate assumes the whole weight of the recovery process so that further nominal (and also real) exchange rate depreciations are needed to enhance the competitiveness of the domestic products in the international goods markets and so to return to the NAIRU-production level.

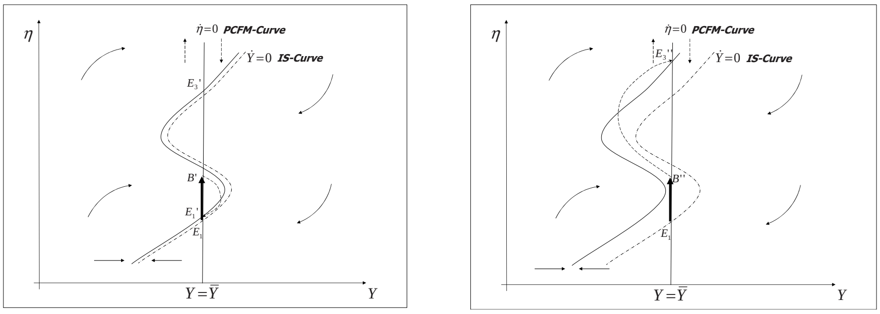
4.2 The Case of Partial Liability Dollarization 0< υ <1: Modelling the Exchange Rate Policy Dilemma

We now analyse the dynamics of the model for the case where a fraction of the domestic firms does not issue foreign-currency debt but instead finances its investment projects by domestic currency denominated credit. Despite the fact that the $\dot{Y} = 0-$isocline has basically the same shape as in the previous section, as stated before, the magnitude of the balance-sheet effect on the aggregate investment and therefore on the aggregate demand depends on the degree of dollarization of liabilities in the economy.

As previously discussed, in an economy with liabilities denominated only partially in foreign currency, during a speculative attack on the domestic currency the monetary authorities are confronted with a lose-lose situation. Exactly this situation is represented when $0 < \upsilon < 1$. In this case an increase of the domestic interest rate (through a reduction of the money supply) has a direct effect on the aggregate investment due to a subsequent decrease of the investments undertaken by the fraction $(1 - \upsilon)$ of domestic firms. In our model, such a response to a speculative attack on the domestic currency does not only influence the dynamics of $\dot{\eta}$, but it also shifts the $\dot{Y} = 0-$isocline to the left reducing the aggregate investment and demand, as sketched in figures 6 and 7. In the next sections we show that this potential counterproductiveness of an increase in the domestic interest rate by the monetary authorities depends on the elasticity of the aggregate demand with respect to interest rate changes.

4.2.1 Dynamics after a Successful Defense of the Currency Peg

Under the assumption that the increase in the domestic nominal interest rate by monetary authorities succeeds in lowering the pressure in the foreign exchange market so that the prevailing exchange rate (or currency peg in case of a fixed exchange rate regime) remains at its former level (or just slightly deviates from it), two scenarios are possible. If the elasticity of the aggregate investment with respect to domestic interest rate changes is low (and/or the degree of liability dollarization in the economy is particularly high), the $\dot{Y} = 0-$isocline will not significantly shift to the left and the economy will return to an equilibrium point very similar to the pre-crisis equilibrium situation after a short term period of slight over-production and -employment and a moderate domestic inflation, as sketched in figure 6a. If, on the contrary, the elasticity of the aggregate demand to interest rate changes is high (and/or the degree of liability dollarization is low), the IS-Curve will significantly shift to the left and the $E1$ equilibrium point might be missed, as sketched in figure 6b.



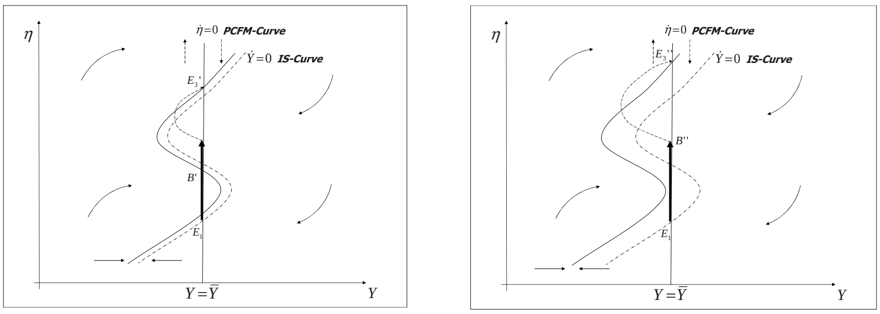
a) b)

Figure 6: Real Exchange Rate and Output Dynamics resulting from a Successful Defense of the Exchange Rate Level under a) Low and b) High Interest Rate Elasticity of the Aggregate Investment

In this second case an increase in the domestic interest rate will thus lead to a severe economic slowdown in the short run due to the fall in the aggregate demand despite of the successful defense of the nominal exchange rate. In the medium run, the equilibrium point $E3$ is the only steady state to which the economy can converge to. Since $Y < \bar{Y}$, the domestic price level will fall and $\dot{\eta} > 0$, even though the nominal exchange rate might be fixed. This decrease in the domestic price level enhances the competitiveness of the domestic products in the international markets, thus expanding the export volume and leading the economy in the medium run to the full-employment level $E3$, nevertheless with a different composition, namely high exports and depressed investments. Note nevertheless that this recovery process might only take place if the domestic wages and prices fall sufficiently to enhance in a significant way the competitiveness of the domestic goods. If the domestic nominal wages and prices are downwardly rigid as empirically is the case in the majority of modern economies, then the economy might stay for a longer period in an unemployment situation where the nominal exchange rate is constantly under pressure. The government and the monetary authorities have in that case two alternatives: either the government expands its expenditures (shifting the IS-Curve back to the right) or the monetary authorities give in to the foreign exchange market pressure and devaluate the domestic currency, accelerating so the recovery process to $E3$.

4.2.2 Dynamics after a Failed Defense of the Currency Peg

The two possible scenarios discussed in the previous section were based on the assumption that an interest rate increase by the domestic monetary authorities is successful in the defense of the prevailing exchange rate (or currency peg in case of a fixed exchange rate regime). Nevertheless, as the majority of currency crises in the last decades have demonstrated, the foreign exchange market pressure can be of such a magnitude that the monetary authorities might be forced to devalue or let the nominal exchange rate float. In such a case the currency mismatch between the assets and liabilities of the fraction of domestic firms which finance their investment projects through foreign currency credit takes place all in all, leading to the activation of credit constraints by the financial sector and to a fall of the investment of the group of domestic firms indebted in foreign currency. The investment of the remaining firms, which actually does not depend on the level of the nominal exchange rate, is also affected due to the domestic interest rate increases undertaken by the monetary authorities in their effort to defend the currency peg. The aggregate consequences for the economy are then catastrophic, since not a fraction, but the complete investment by entrepreneurial sector is depressed. The extent of the investment decrease depends, of course, on the interest rate elasticity of the aggregate demand, as shown in figure 7.



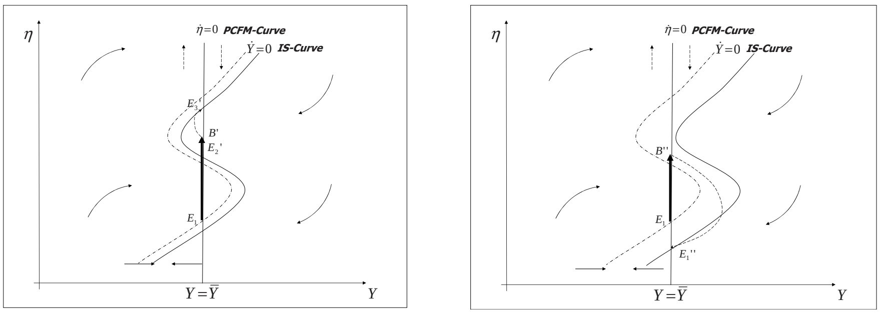
a) b)

Figure 7: Real Exchange Rate and Output Dynamics resulting from a Failed Defense of the Exchange Rate Level under a) Low and b) High Interest Rate Elasticity of the Aggregate Investment

Figures 7a and 7b show an important insight: the higher the interest rate elasticity of the aggregate demand, the longer is the recession period the economy experiences after the currency breakdown and the higher is equilibrium real exchange rate to which the economy converges in the medium run as shown in figure 7b. These results are intuitive: the higher the interest rate elasticity of the aggregate demand, the greater is the investment decrease and therefore the real exchange rate increase which is needed for the economy to return to its NAIRU level of employment and production. We see thus that a failed defense of the prevailing exchange rate by the monetary authorities can have disastrous implications for the short- and medium run performance of the economy.

4.2.3 An Unorthodox Measure against a Speculative Attack

Due to the potential occurrence of the scenarios discussed above some researchers like Jeffrey Sachs have pledged that not an *increase*, but a *decrease* in the domestic interest rate is the right measure during a speculative attack on the domestic currency. Indeed, since the exchange rate *per se* does not have a real meaning for the economic development, the monetary authorities might decide to bring the foreign exchange market turmoil behind them once and for all and to stabilize or even to enhance the economic activity by lowering the interest rates, irrespective of the exchange rate level. Such a measure will induce an even greater nominal exchange rate depreciation, i.e. a jump from $E1$ to B' as sketched in figure 8. As shown there, the resulting dynamics depend on whether the new nominal (and real in the short run) exchange rate lies beneath or above the unstable new steady state $E2''$.



a) b)

Figure 8: Two Possible Consequences of an Interest Rate Decrease as a Response to a Speculative Attack a in Economy with Dollarized Liabilities

In figure 8a, where the interest rate elasticity of the aggregate demand is low, the $IS-$Curve does not significantly shift to the right after the interest rate decrease, so that B' lies above $E2''$ in the short run. The economy will experiment in this case a period of underemployment, depressed investment of the fraction of domestic firms indebted in foreign currency (due to the increase of the domestic currency value of the foreign currency liabilities of that group) and falling prices (since $Y < \bar{Y}$) until $E3'$ is reached. Again, the enhancement of the net exports via real depreciation is the channel which enables the economy to return to its NAIRU level of employment. Nevertheless, the output loss in this case will probably be lower and the duration of the economic slowdown shorter than in the previous cases where the exchange rate was successfully defended but the aggregate investment was severely damaged, as sketched in figure 7.

In figure 8b, where the interest rate elasticity of the aggregate demand is high, the aggregate investment rises due to the decrease of the domestic interest rate, shifting the $IS-$Curve significantly to the right (perhaps even so much that E_3 disappears as sketched above), so that B' lies below $E2''$ in the short run (if E_2 still exists), the domestic interest rate decrease overcomes the negative balance sheet effect resulting form the nominal depreciation of the domestic currency. In this scenario this nominal devaluation finally leads to an increase in the net exports and therefore, together with the higher aggregate investment, to a period of over-production and -employment in the economy. Nevertheless, due to the resulting increase in the domestic price level (since $Y > \bar{Y}$), the domestic products will loose competitiveness and the net exports will decrease over time, leading the economy to its NAIRU production level at $E1'$.

4.3 Interest Rate Sensitivity Analysis

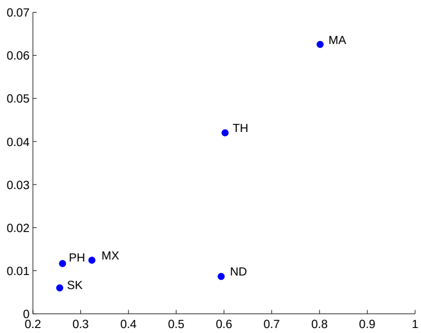
In this section we attempt to identify in a more precise manner the main determinant of the sharp investment decline in the analysed countries and in this way to control for the real world relevance of the scenarios discussed in the previous section. Nevertheless, due to the uniqueness and high non-linearity of these financial episodes and to the fact that both variables, nominal exchange rates *as well as* domestic interest rates experienced the same "jumps" in the same time intervals, as also due to the small number of available time series data, a direct econometric identification of the main determinants (the nominal exchange rate depreciations or the sharp interest rate increases) for these sharp investment declines is extremely difficult to perform.

We therefore pursue an alternative, indirect strategy which can be summarized in the following way: We first estimate the elasticity of aggregate investment with respect to the domestic interest rate in the pre-crisis sub-samples of selected emerging market countries. Thus, we estimate the intrinsic reaction of the economies with respect to domestic interest rate increases (irrespective of their cause) before the respective currency and financial crises.[11] For our analysis we use the same variables as in the VARX analysis of a previous section. The OLS estimation results concerning the pre-crisis interest rate semi-elasticities (autoregressive terms as well as seasonal dummies and trends are omitted here but are available upon request) in the pre-crisis sub-sample are reported in table 2.

Table 2: Domestic Interest Rate Semi-Elasticity of Aggregate Investment: OLS Estimations Results

Sample Period	Expl. Variable	Coeff.	Std. Errors	t-Stat.	R^2
1991Q4-1994Q4	MX_tbillrate(t-2)	-0.012	0.001	-6.226	0.771
1991Q3-1997Q4	MA_lendrate(t-1)	-0.062	0.016	-3.882	0.938
1993Q4-1996Q4	TH_lendrate(t-3)	-0.042	0.003	-11.258	0.992
1990Q4-1997Q2	ND_moneyrate(t-3)	-0.008	0.002	-3.674	0.959
1981Q1-1997Q2	SK_tbillrate(t-3)	-0.006	0.002	-2.996	0.990
1990Q4-1997Q2	PH_tbillrate(t-3)	-0.011	0.004	-2.842	0.767

Figure 2 shows the estimated pre-crisis semi-elasticities of the selected countries plotted against the post-crisis output loss. A positive correlation can be observed between the interest rate semi-elasticity of aggregate demand and the subsequent output loss after the respective sharp nominal exchange rate devaluations. Apparently the countries with the higher interest rate semi-elasticities were the ones with the higher output loss after the respective currency and financial crises.



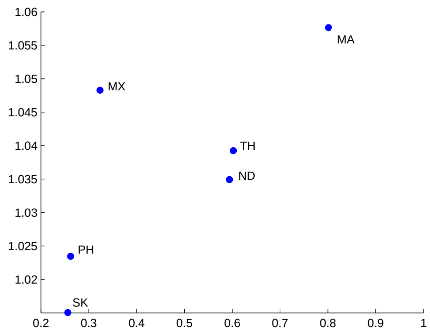
	Pre-Crisis Semi-Elast.	Post-Crisis Output Loss
MX	0.012	0.323 (95Q2)
MA	0.062	0.801 (98Q3)
TH	0.042	0.602 (98Q2)
ND	0.008	0.594 (99Q1)
SK	0.006	0.256 (97Q3)
PH	0.011	0.262 (98Q4)

Figure 9: Interest Rate Semi-Elasticity (Y-Axis) and Output Loss (X-Axis)

Because the domestic interest rate increases resulting in part from the defense of the currency peg were not of the same magnitude across the countries, we try to

[11]We do not do the same for the exchange rate elasticity of the aggregate investment since, from the theoretical point of view, in tranquil periods no direct relationship between these two variables can be expected. The effect of a nominal depreciation on investment is theoretically defined as highly nonlinear, see Krugman (2000).

approximate the direct impact of these interest rate increases on aggregate investment during the speculative attacks by weighting geometrically these interest rate increases with the respective country-specific semi-elasticities of the aggregate investment (we assume here that the interest rate elasticity of aggregate investment remained unchanged by the respective crises). We plot then in figure 10 the resulting series again against the respective post-crisis output loss (proxied by the negative growth rates of aggregate investment after the respective crises marked by the shaded areas in figure 1).



	Interest Rate Impact	Post-Crisis Output Loss
MX	1.048	0.323 (95Q2)
MA	1.057	0.801 (98Q3)
TH	1.039	0.602 (98Q2)
ND	1.034	0.594 (99Q1)
SK	1.009	0.256 (97Q3)
PH	1.023	0.262 (98Q4)

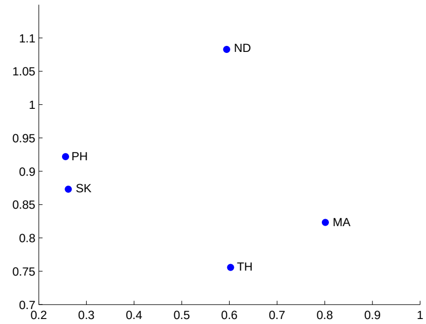
Figure 10: Interest Rate Impact (Y-Axis) and Post-Crisis Output Loss (X-Axis)

As expected, a positive correlation can be observed. This graphical result can be interpreted in the following way: a sharp increase in the domestic interest rates caused in countries with a high intrinsic interest rate elasticity a greater output loss than in countries where the elasticity was low. For comparison we show in figure 11 the largest exchange rate increase, geometrically weighted with the end of 1996 short term liabilities to BIS banks (as percentage of GDP).[12]

Surprisingly, it seems that the great nominal exchange rate devaluation, weighted by the intrinsic degree of liability dollarization in the respective economies, is less correlated with the large output losses observed in the quarters following the currency and financial crises than the interest rate increases. These results deliver a new insight on the real causes for the large output decrease in the countries facing a speculative attack on their currencies and relativizes the importance of the liability dollarization issue for the development of aggregate investment.

As stated before, the lack of adequate data represents a great problem for the empirical analysis of the Mexican and East Asian Crises since it makes the econometric

[12]This measure is commonly used as a proxy for the degree of liability dollarization in an economy, see e.g. Goldstein and Turner (2004). Other proxies for the degree of liability dollarization in the economy as the ratio of short term liabilities to foreign reserves or the ratio of liabilities to assets towards BIS banks delivered similar results.



	Exchange Rate Impact	Post-Crisis Output Loss
MA	0.823	0.801 (98Q3)
TH	0.755	0.602 (98Q2)
ND	1.082	0.594 (99Q1)
SK	0.092	0.256 (97Q3)
PH	0.873	0.262 (98Q4)

Figure 11: Exchange Rate Impact (Y-Axis) and Post-Crisis Output Loss (X-Axis)

analysis more difficult in a great manner due to the small number of observations available. Nevertheless, we think that the basic procedure discussed in this section delivers some insights on the true determinants of the large output losses after these currency and financial crises.

5 Conclusions

The right strategy to be followed by the domestic monetary authorities during a speculative attack is an issue which is far from being solved and which will attract the attention of researchers and policy makers in the coming years. We contribute to this discussion by showing in a theoretic framework that both strategies (the increase or decrease the domestic interest rates) can turn out to be beneficial for the short and medium run performance of the economy. In our model the traditional strategy (backed by the IMF during the East Asian Crisis) of raising the interest rates proves to be counterproductive if the aggregate demand reacts (more) elastically to domestic interest rate changes (than to nominal exchange rate devaluations). This strategy can turn out to be the adequate one only if the interest rate changes do not affect in a great manner the aggregate investment and therefore the aggregate demand of the economy.

The most unorthodox alternative, namely a decrease in the interest rates, might be considered as more problematic from the short run point of view since it might provoke an even more sharper depreciation of the nominal exchange rate. Nevertheless, such a measure might be more beneficial in the medium run since a) it might lower the output loss and the duration of the economic recession or b) it might induce a short run over employment situation through a real exchange rate depreciation and a resulting expansion of the net exports volume as well as an inflationary process.

These results, together with the empirical findings of the last section, highlight the importance of the consideration of country-specific characteristics in the exchange rate policy making. Ready-made solutions of the *one-size-fits-all* type can bring heterogeneous and, more important, adverse results in countries with different characteristics. If the fraction of the liabilities denominated in foreign currency is not significantly high and the aggregate demand of the remaining firms react elastically to interest rate changes, the unorthodox alternative of lowering the interest rate and let the nominal exchange rate float might be a better medium run oriented strategy for the domestic monetary authorities to follow, even if its short run effects might seem radical and counterproductive.

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6 Appendix

6.1 Descriptive Statistics

Table 3: Descriptive Statistics

Country	Variable	Sample	Obs	Mean	Min	Max	Std.Dev	JB-Prob.
MX	exchrate_lg	1990Q1-2003Q1	53	1.764	0.989	2.022	0.518	0.023
	tbillrate_lg	1990Q1-2003Q1	53	2.917	1.880	4.100	0.523	0.917
	investment_lg	1990Q1-2003Q1	53	5.971	5.613	6.274	0.175	0.269
MA	exchrate_lg	1991Q1-2003Q1	49	1.123	0.901	1.400	0.197	0.024
	lendrate_lg	1991Q1-2003Q1	49	2.080	1.854	2.502	0.167	0.367
	investment_lg	1991Q1-2003Q1	49	9.828	9.498	10.32	0.231	0.135
TH	exchrate_lg	1993Q1-2002Q1	37	3.471	3.203	3.852	0.247	0.084
	lendrate_lg	1993Q1-2002Q1	37	2.375	1.945	2.724	0.256	0.180
	investment_lg	1993Q1-2002Q1	37	5.729	5.286	6.186	0.289	0.158
ND	exchrate_lg	1990Q1-2001Q4	48	7.742	7.502	9.413	0.695	0.023
	moneyrate_lg	1990Q1-2001Q4	48	2.566	1.900	4.306	0.577	0.000
	investment_lg	1990Q1-2001Q4	48	10.282	9.586	10.77	0.208	0.009
SK	exchrate_lg	1990Q1-2003Q1	53	6.861	6.554	7.435	0.248	0.064
	tbillrate_lg	1990Q1-2003Q1	53	2.259	1.386	3.173	0.524	0.064
	investment_lg	1990Q1-2003Q1	53	10.35	10.00	10.54	0.126	0.342
PH	exchrate_lg	1990Q1-2003Q1	53	3.489	3.118	3.990	0.284	0.041
	lendrate_lg	1990Q1-2003Q1	53	2.505	1.531	2.541	0.396	0.630
	investment_lg	1990Q1-2003Q1	53	4.676	4.379	4.676	0.128	0.306

6.2 Statistics for VARX Model Selection

Table 4: Schwarz Bayesian VAR Lag Length Selection Criteria

Lags	MX	MA	TH	ND	SK	PH
0	1.474	-1.591	-0.848	2.999	-0.700	-0.917
1	-7.739	-7.510*	-7.175*	-3.373*	-7.659	-6.671*
2	-7.905*	-7.215	-6.872	-3.240	-8.117*	-6.314
3	-7.577	-6.971	-6.905	-3.142	-8.094	-5.896
4	-7.434	-6.921	-6.567	-3.039	-7.583	-5.354
5	-6.856	-6.370	-5.967	-2.836	-7.044	-4.899
6	-6.370	-5.762	-5.725	-2.528	-6.690	-4.544

Table 5: Residual Serial Correlation LM-Tests
H0: No Serial Correlation at Lag Order h. Probs from Chi-Square with 9 DFs

Lag	MX	MA	TH	ND	SK	PH
1	0.1479	0.0049	0.1349	0.0034	0.0002	0.1346
2	0.8761	0.0070	0.1832	0.3669	0.2340	0.0595
3	0.6915	0.3359	0.0195	0.3207	0.8823	0.8778
4	0.7882	0.2362	0.9898	0.3292	0.8882	0.1344
5	0.7046	0.6483	0.0031	0.0173	0.2753	0.2362
6	0.0283	0.3015	0.0288	0.8298	0.6693	0.0910
7	0.4765	0.5400	0.2478	0.9164	0.8256	0.0066
8	0.2146	0.8300	0.8809	0.6179	0.2686	0.4955
9	0.9168	0.7342	0.5277	0.7469	0.8055	0.1958
10	0.9653	0.3624	0.4262	0.9871	0.6591	0.6801

6.3 VARX Estimation Results

6.3.1 Mexico

Vector Autoregression Estimates
Date: 10/10/05 Time: 22:22
Sample (adjusted): 1990Q3 2003Q1
Included observations: 51 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	MX_EXCHRATE_LG	MX_TBILLRATE_LG	MX_INVESTM95_LG_SA
MX_EXCHRATE_LG(-1)	1.117042	1.390330	-0.132268
	(0.11705)	(0.60308)	(0.12591)
	[9.54294]	[2.30538]	[-1.05047]
MX_EXCHRATE_LG(-2)	-0.092006	-1.430013	0.165713
	(0.12144)	(0.62570)	(0.13064)
	[-0.75760]	[-2.28546]	[1.26851]
MX_TBILLRATE_LG(-1)	-0.035370	0.728756	-0.052744
	(0.03551)	(0.18295)	(0.03820)
	[-0.99606]	[3.98331]	[-1.38084]
MX_TBILLRATE_LG(-2)	0.012133	0.127569	0.047817
	(0.03665)	(0.18885)	(0.03943)
	[0.33101]	[0.67550]	[1.21274]
MX_INVESTM95_LG_SA(-1)	-0.086000	1.089350	1.030374
	(0.10722)	(0.55242)	(0.11534)
	[-0.80208]	[1.97196]	[8.93368]
MX_INVESTM95_LG_SA(-2)	-0.041132	-0.953798	-0.182227
	(0.10145)	(0.52269)	(0.10913)
	[-0.40544]	[-1.82477]	[-1.66982]
C	0.796970	-0.422011	0.873311
	(0.34213)	(1.76272)	(0.36803)
	[2.32942]	[-0.23941]	[2.37296]
I9501	0.489680	1.166326	-0.118802
	(0.03362)	(0.17323)	(0.03617)
	[14.5641]	[6.73289]	[-3.28481]
R-squared	0.996430	0.906154	0.962752
Adj. R-squared	0.995848	0.890877	0.956688
Sum sq. resids	0.045687	1.212756	0.052864
S.E. equation	0.032596	0.167939	0.035063
F-statistic	1714.350	59.31425	158.7728
Log likelihood	106.5870	22.97686	102.8664
Akaike AIC	-3.866156	-0.587328	-3.720249
Schwarz SC	-3.563125	-0.284296	-3.417218
Mean dependent	1.794499	2.886059	5.982341
S.D. dependent	0.505888	0.508388	0.168478
Determinant resid covariance (dof adj.)			1.66E-08
Determinant resid covariance			9.93E-09
Log likelihood			252.8171
Akaike information criterion			-8.973220
Schwarz criterion			-8.064126

6.3.2 Malaysia

Vector Autoregression Estimates
Date: 10/10/05 Time: 21:43
Sample (adjusted): 1991Q2 2003Q1
Included observations: 48 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	MA_EXCHRATE_LG	MA_LENDRATE_LG	MA_INVESTM95_LG
MA_EXCHRATE_LG(-1)	1.048237	-0.088514	-0.308764
	(0.03582)	(0.04883)	(0.09362)
	[29.2633]	[-1.81282]	[-3.29790]
MA_LENDRATE_LG(-1)	0.051525	0.891228	-0.202598
	(0.03906)	(0.05325)	(0.10210)
	[1.31900]	[16.7375]	[-1.98430]
MA_INVESTM95_LG(-1)	0.100578	0.073856	0.758094
	(0.02824)	(0.03850)	(0.07382)
	[3.56118]	[1.91847]	[10.2698]
C	-1.143211	-0.403560	3.150424
	(0.30796)	(0.41978)	(0.80492)
	[-3.71215]	[-0.96136]	[3.91396]
R-squared	0.959408	0.895823	0.795945
Adj. R-squared	0.956640	0.888720	0.782032
Sum sq. resids	0.075256	0.139824	0.514096
S.E. equation	0.041357	0.056372	0.108093
F-statistic	346.6524	126.1193	57.20934
Log likelihood	86.88445	72.01670	40.76806
Akaike AIC	-3.453519	-2.834029	-1.532003
Schwarz SC	-3.297585	-2.678096	-1.376069
Mean dependent	1.126030	2.081734	9.835239
S.D. dependent	0.198610	0.168988	0.231526
Determinant resid covariance (dof adj.)			5.50E-08
Determinant resid covariance			4.23E-08
Log likelihood			203.1401
Akaike information criterion			-7.964170
Schwarz criterion			-7.496370

6.3.3 Thailand

```
======================================================================
 Vector Autoregression Estimates
 Date: 10/10/05   Time: 16:36
 Sample (adjusted): 1993Q2 2002Q1
 Included observations: 36 after adjustments
 Standard errors in ( ) & t-statistics in [ ]
----------------------------------------------------------------------
                    TH_EXCHRATE_LG  TH_LENDRATE_LG  TH_INVESTM95_LG_SA
TH_EXCHRATE_LG(-1)      1.051637        0.125351       -0.427544
                       (0.09820)       (0.06423)       (0.10518)
                       [10.7088]       [1.95171]       [-4.06480]
TH_LENDRATE_LG(-1)     -0.020570        0.919620       -0.156389
                       (0.05598)       (0.03661)       (0.05996)
                      [-0.36745]       [25.1177]       [-2.60826]
TH_INVESTM95_LG_SA(-1)  0.088368        0.250897        0.708782
                       (0.08405)       (0.05497)       (0.09002)
                       [1.05141]       [4.56438]       [7.87357]
C                      -0.621381       -1.694095        3.516344
                       (0.78581)       (0.51393)       (0.84166)
                      [-0.79075]      [-3.29632]      [4.17789]
----------------------------------------------------------------------
 R-squared              0.927020        0.971642        0.940096
 Adj. R-squared         0.920179        0.968983        0.934480
 Sum sq. resids         0.157059        0.067180        0.180176
 S.E. equation          0.070058        0.045819        0.075037
 F-statistic            135.4930        365.4723        167.3965
 Log likelihood         46.74196        62.02827        44.27035
 Akaike AIC            -2.374553       -3.223793       -2.237242
 Schwarz SC            -2.198607       -3.047846       -2.061295
 Mean dependent         3.477958        2.373742        5.726225
 S.D. dependent         0.247969        0.260164        0.293148
 Determinant resid covariance (dof adj.)                4.83E-08
 Determinant resid covariance                           3.39E-08
 Log likelihood                                         156.3554
 Akaike information criterion                          -8.019745
 Schwarz criterion                                     -7.491905
 =====================================================================
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6.3.4 Indonesia

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======================================================================
 Vector Autoregression Estimates
 Date: 10/14/05   Time: 17:38
 Sample (adjusted): 1990Q2 2001Q4
 Included observations: 47 after adjustments
 Standard errors in ( ) & t-statistics in [ ]
----------------------------------------------------------------------
                    ND_EXCHRATE_LG  ND_MONEYRATE_LG ND_INVESTM95_LG_SA
ND_EXCHRATE_LG(-1)      0.977995       -0.040763       -0.004416
                       (0.02539)       (0.06442)       (0.03288)
                       [38.5210]       [-0.63275]      [-0.13428]
ND_MONEYRATE_LG(-1)    -0.007791        0.832161       -0.044933
                       (0.03118)       (0.07910)       (0.04038)
                      [-0.24991]       [10.5198]       [-1.11278]
ND_INVESTM95_LG_SA(-1)  0.128087        0.393532        0.662844
                       (0.07624)       (0.19345)       (0.09874)
                       [1.68010]       [2.03433]       [6.71273]
C                      -1.096294       -3.254417        3.625069
                       (0.75866)       (1.92503)       (0.98263)
                       [-1.44504]      [-1.69058]      [3.68915]
I9801                   0.819036        0.427136        0.396342
                       (0.10653)       (0.27032)       (0.13798)
                       [7.68810]       [1.58013]       [2.87239]
----------------------------------------------------------------------
 R-squared              0.980787        0.821990        0.591699
 Adj. R-squared         0.978957        0.805036        0.552813
 Sum sq. resids         0.428130        2.756487        0.718227
 S.E. equation          0.100963        0.256185        0.130769
 F-statistic            536.0038        48.48532        15.21632
 Log likelihood         43.72406       -0.039629        31.56615
 Akaike AIC            -1.647832        0.214452       -1.130474
 Schwarz SC            -1.451008        0.411277       -0.933650
 Mean dependent         8.172014        2.739347        10.28690
 S.D. dependent         0.696003        0.580198        0.195552
 Determinant resid covariance (dof adj.)                1.05E-05
 Determinant resid covariance                           7.46E-06
 Log likelihood                                         77.36642
 Akaike information criterion                          -2.653890
 Schwarz criterion                                     -2.063417
 =====================================================================
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6.3.5 South Korea

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======================================================================
 Vector Autoregression Estimates
 Date: 10/14/05   Time: 16:05
 Sample (adjusted): 1990Q3 2003Q1
 Included observations: 51 after adjustments
 Standard errors in ( ) & t-statistics in [ ]
======================================================================
                    SK_EXCHRATE_LG  SK_TBILLRATE_LG SK_INVESTM95_LG_SA
SK_EXCHRATE_LG(-1)      0.666015        0.443194       -0.236598
                       (0.05834)       (0.15548)       (0.05237)
                       [11.4170]       [2.85052]       [-4.51741]
SK_EXCHRATE_LG(-2)      0.239331       -0.849955        0.149110
                       (0.06234)       (0.16615)       (0.05597)
                       [3.83911]       [-5.11552]      [2.66411]
SK_TBILLRATE_LG(-1)     0.013442        1.140675       -0.044824
                       (0.03878)       (0.10337)       (0.03482)
                       [0.34659]       [11.0352]       [-1.28729]
SK_TBILLRATE_LG(-2)    -0.033382       -0.332019        0.001586
                       (0.03635)       (0.09688)       (0.03263)
                       [-0.91836]      [-3.42714]      [0.04859]
SK_INVESTM95_LG_SA(-1)  0.070488       -0.047530        0.833021
                       (0.16202)       (0.43182)       (0.14546)
                       [0.43506]       [-0.11007]      [5.72664]
SK_INVESTM95_LG_SA(-2)  0.018711        0.104549        0.073021
                       (0.15352)       (0.40918)       (0.13784)
                       [0.12188]       [0.25551]       [0.52977]
C                      -0.226742        2.603912        1.682887
                       (0.61375)       (1.63579)       (0.55103)
                       [-0.36944]      [1.59184]       [3.05406]
I9704                   0.606830        0.298917       -0.008398
                       (0.03999)       (0.10658)       (0.03590)
                       [15.1751]       [2.80464]       [-0.23392]
======================================================================
 R-squared              0.979159        0.968207        0.919313
 Adj. R-squared         0.975767        0.963032        0.906178
 Sum sq. resids         0.062817        0.446219        0.050635
 S.E. equation          0.038221        0.101868        0.034316
 F-statistic            288.6120        187.0741        69.98889
 Log likelihood         98.46787        48.47282        103.9651
 Akaike AIC            -3.547760       -1.587169       -3.763338
 Schwarz SC            -3.244728       -1.284138       -3.460307
 Mean dependent         6.873426        2.246830        10.36750
 S.D. dependent         0.245526        0.529817        0.112031
 Determinant resid covariance (dof adj.)                1.42E-08
 Determinant resid covariance                           8.53E-09
 Log likelihood                                         256.6891
 Akaike information criterion                          -9.125062
 Schwarz criterion                                     -8.215968
 ======================================================================
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6.3.6 Philippines

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=======================================================================
 Vector Autoregression Estimates
 Date: 10/14/05   Time: 16:33
 Sample (adjusted): 1990Q2 2003Q1
 Included observations: 52 after adjustments
 Standard errors in ( ) & t-statistics in [ ]
-----------------------------------------------------------------------
                    PH_EXCHRATE_LG  PH_TBILLRATE_LG  PH_INVESTM95_LG_SA
PH_EXCHRATE_LG(-1)      0.988844       -0.207142       -0.016199
                       (0.03074)       (0.10343)       (0.04474)
                       [32.1660]       [-2.00269]      [-0.36202]
PH_TBILLRATE_LG(-1)     0.014932        0.853845       -0.095878
                       (0.02319)       (0.07801)       (0.03375)
                       [0.64405]       [10.9457]       [-2.84116]
PH_INVESTM95_LG_SA(-1)  0.121817        0.042144        0.676212
                       (0.06446)       (0.21689)       (0.09383)
                       [1.88970]       [0.19431]       [7.20706]
C                      -0.553068        0.862541        1.813348
                       (0.32911)       (1.10730)       (0.47902)
                       [-1.68049]      [0.77896]       [3.78554]
I9703                   0.088181        0.239549        0.091358
                       (0.04814)       (0.16196)       (0.07007)
                       [1.83180]       [1.47902]       [1.30388]
-----------------------------------------------------------------------
 R-squared              0.975973        0.859464        0.758825
 Adj. R-squared         0.973928        0.847503        0.738300
 Sum sq. resids         0.097909        1.108331        0.207418
 S.E. equation          0.045642        0.153563        0.066432
 F-statistic            477.2731        71.85829        36.96991
 Log likelihood         89.36406        26.27329        69.84602
 Akaike AIC            -3.244771       -0.818203       -2.494078
 Schwarz SC            -3.057152       -0.630584       -2.306458
 Mean dependent         3.496652        2.495650        4.677349
 S.D. dependent         0.282666        0.393238        0.129859
 Determinant resid covariance (dof adj.)                1.59E-07
 Determinant resid covariance                           1.18E-07
 Log likelihood                                         193.5177
 Akaike information criterion                          -6.866063
 Schwarz criterion                                     -6.303205
 ======================================================================
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